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LIST OF EXHIBITS (continued)

3.5-3(3) Diversion Structures

A diversion has been constructed in the Adit area to convey storm runoff from the base of watershed ACWS-U1. The characteristics of watershed ACWS-U1 are listed in Table 3.5-1. The location of this diversion is shown on Exhibit 3.5-2. Based on the watershed characteristics and measurements taken in the field to determine the shape and slope of the diversion, a minimum ditch size was determined. The existing diversion approximates a trapezoid in cross section in some places and a triangle in others. The side slopes are approximately 1.5(H):1(V). Actual flow depths were based on the minimum diversion slope, while the maximum flow velocity and riprap sizing was calculated based on the maximum slope. The resulting minimum geometry of the diversion and riprap required is presented in Table 3.5-2. As mentioned at the base of the table, the requirement for riprap does not apply to well vegetated sections of the diversion where the slope of the diversion is less than 5%.

3.5-3(4) Sedimentation Pond 010

Sedimentation Pond 010 is located in the Adit No. 1 area to control the storm runoff from the disturbed drainage areas at the site. This sediment pond, was reconstructed in September-October of 1991 and resurveyed by a Professional Engineer. Horizontal and vertical control bench marks were not available for the survey, so initial coordinates and elevations were assumed, relative to an assumed elevation of the embankment. The topography and cross sections for Pond 010 are contained on Exhibit 3.5-4. A description of the construction methods and the certification of the as-built survey for Pond 010 are contained in Appendix 3.5F.

The sediment storage volume of 742 cubic feet (0.017 acre-feet) was calculated as indicated in Appendix 3.5A using methods described in Chapter 7. The storm runoff volume from the 10-year 24-hour storm event (P = 1.8", Miller et al, 1973) is 8406 cubic feet (0.193 acre-feet). The computation of the runoff volume assumed a total drainage area of 6.2 acres,

ADIT NO. 1 AS-BUILT RECLAMATION
CASTLE GATE MINE

CASTLE GATE COAL MINE
Carbon County, Utah

April 2005

APPENDIX 3.5I

ADIT NO. 1 (Utah Fuel No. 1)

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(MS denotes the map section of the permit. The maps are not included in this appendix.)

3.5-4AB Reclamation Plan

The reclamation work at Adit No. 1 was completed in the fall of 2002. The reclamation of Adit No. 1 encompassed the area around the portals, the box culvert under the highway and the tube that crosses the Price River. The as-built reclamation of the site is shown on Exhibits 3.5-5AB and 3.5-6AB. The as-built reclamation maps show approximately 1.7 acres of the 3.0 acres of pre-SMCRA disturbance receiving reshaping, diversion reconstruction, resoiling, and revegetation activities. The pre-SMCRA area not receiving reclamation related activities are well vegetated and were not continuously used during the operational phase of the mine.

The postmining land use for the Adit No. 1 area is wildlife habitat.

3.5-4(1)AB Reclamation Work

The reclamation work consisted of the following:

Demolition - All structures within the disturbed area boundary were removed, except as noted below. This includes all beltline structures, the beltline drop structure and foundation, the tube that crosses the Price River and its foundations, beltline buttress foundations, transformers, utility poles and lines. The road inside the disturbed area boundary used to access the transformers was also be removed.

The cut stone retaining walls and concrete brows over the portal entrances were left for historical reference. Adit No. 1 is a mine which dates back to 1888. This date is inscribed in the concrete brow of the portal. The Carbon County Historical Society believes that historic mining structures should be preserved for the enjoyment of future generations and as a monument to those who once lived, worked, and utilized such historical entities (see Appendix

3.5H). The reclamation backfilling and grading facilitated the postmining land use of wildlife habitat.

The concrete box culvert, which contained the beltline and passes under the US Highway was left in place to convey runoff under the highway to the Price River. Water discharging from the portal is conveyed to this structure via the reclamation channels.

Nonhazardous and nonflammable materials, such as concrete, and steel reinforced concrete were used as backfill in areas such as cutslopes and depressions caused by the removal of facilities. These materials were incorporated into the backfill in a manner that did not create voids within the backfill or reduce the effective compaction necessary for backfilling. These materials were intermixed with backfill to ensure voids were filled. Additionally, the top four feet of soil was clean and contained minimal, if any, non-coal waste. Concrete slabs or foundations buried in-place were covered with a minimum of four feet of fill to ensure adequate root depth and soil moisture retention for vegetation. Whenever possible, steel was salvaged rather than buried. However, rebar or other steel that is incorporated in the concrete was not removed from the concrete prior to burial.

Other non-coal wastes found during demolition, or other reclamation activities, including, but not limited to grease, lubricant, paints, flammable liquids, garbage, abandoned mining machinery, lumber, and other combustible materials generated during previous mining activities were disposed of in a State-approved solid waste disposal facility

Portal Sealing - The portals which lie within the disturbed area boundary were sealed in 1991 according to the plans shown in Figures 3.1-3 and 3.1-4 of the permit. The water discharging from the portal, via a pipe, is conveyed to the Price River. The pipe draining water

out of the adit was installed in a free-draining and non-plugging manner (Appendix 3.5C). The outlet for the water is within the reclamation channel.

Grading - During the grading process, the following work was performed:

1. Elimination of berms and temporary diversions (ACD-1 and ACD-2),
2. Grading to establish surface overland flow drainage where possible,
3. Construction of permanent stream channels,
4. Removal of parking and storage surfaces prior to placement of soil,
5. Removal of Sediment Pond 010, and
6. Construction of alternative sediment controls (see Section 3.5-4(3)AB).

The site was graded to permit overland flow of storm runoff to the permanent reclamation channels, as shown on Exhibit 3.5-5AB. Sediment Pond 010 was left in place as long as possible during reclamation activities to provide sediment control

.

Backfill and Grading. The disturbed area was graded to the approximate original contour by blending spoil into the surrounding area and creating a landform which resembles the surrounding terrain. Reclamation slopes are concave in cross-section to the extent possible and do not exceed a slope of 2H:1V. The sandstone cliff which exists on the north and south side of the portal remain exposed.

To the extent possible, existing cut slopes were backfilled during reclamation operations. However, due to the extent of pre-SMCRA disturbances in the canyon, the maximum slope of 2:1, and availability of spoil material, some cut slopes remain. Remaining cut slopes are shown on Exhibit 3.5-5AB.

Backfilling of the pre-SMCRA portal face-ups was accomplished by placing available fill material to the height of the portals and blending the fill into the surrounding slopes. Thereby

creating a final surface configuration compatible with the postmining land use of wildlife habitat.

Coal debris and acid- and/or toxic-forming material exposed or excavated during reclamation grading was removed, if possible, and used as backfill against cut slopes, or as backfill in depressions caused by removal of facilities. These materials were covered by a minimum of four feet of the best available, nonacid- and/or toxic-forming and noncombustible material

The as-built reclamation grading topography shown on Exhibit 3.5-5AB is compatible with the approved postmining land use of wildlife habitat, and provides adequate drainage and long term stability as required by R645-301.552.

Resoiling -1.7 acres disturbed by mining prior to the advent to SMCRA received resoiling activities. No topsoil was salvaged from the site. The existing soils at the site were used as resoiling materials. The resoiling materials were analyzed, with the results presented in Appendix 3.5G, for the following parameters: pH, electrical conductivity, saturation percentage, particle size analysis, soluble Ca, Mg, and Na, sodium absorption ration, selenium, total N, nitrate-N, boron, maximum acid potential, neutralization potential, total organic carbon, exchangeable sodium.

The reclaimed surface was roughened prior to seeding in order to reduce compaction on all graded areas and improve vegetation establishment.

Seeding and Mulching - Following the grading of the growth media, and prior to application of the reclamation seed mix, certified noxious weed-free hay and/or straw was incorporated into the growth media at a rate of 2 tons per acre. This was done to improve soil

structure for aeration purposes, increase micropore space, and improve the water holding capacity of the soil.

The hay/straw mulch was incorporated to a depth of 12 to 18 inches through deep gouging by using the bucket of a trackhoe. Deep gouging reduces compaction and increases water infiltration. Following deep gouging, the resoiled areas were seeded using Species List #1. See Chapter 9 for the species list. The seed was be spread by broadcasting at a rate double those recommended in the species planting list, in Chapter 9.

Following seeding, an additional 1 to 1.5 tons per acre of certified noxious weed-free straw mulch was spread over the seeded growth media using mechanical blowers with occasional hand spreading. The straw mulch was then sprayed with a tackifier and mulch mixture at about 500 pounds per acre following spreading to retain the straw mulch on the reseeded slopes.

3.5-4(2)AB Reclamation Hydrology

Reclamation Channel Verification - The reclamation channels were constructed using erosion control matting and riprap to create a stable channel. The location of the reclamation channels can be seen on Exhibit 3.5-5AB. Calculations verifying the capacity and stability of the reclamation channels and culverts can be found in Attachment 1 of this appendix.

The natural stream bed that exists upstream of the disturbed area in the Adit No. 1 Canyon can be considered ephemeral since it carries water only in direct response to a precipitation event, or the melting of snow and ice, and is above the local water table. Ephemeral streams are classified as carrying miscellaneous flows, per R645-301-742.330, which requires that permanent diversions be sized for the 10-year 6-hour storm event. Thus,

the reclamation channels are verified to transport the peak discharge of a 10-year 6-hour precipitation event of 1.4 inches (Miller et. al, 1973). Channel reinforcement for these drainages was also based on the peak discharge rates from the 10-year 6-hour precipitation event. A description of the methods used to determine the peak discharge rates are presented in Attachment 1 of this appendix

.

The reclamation channel drainage areas for Adit No. 1 Canyon are presented on Exhibit 3.5-6AB. Curve numbers for the undisturbed drainage areas were estimated from previous calculations presented in Section 3.5-3(2). A curve number of 75 was used for the undisturbed drainage areas and a curve number of 80 was assumed for the reclaimed areas. Curve number calculations are presented in Attachment 1 of this appendix.

To better resemble the natural channels in this canyon an erosion control mat was used to reinforce the reclamation channels. Most natural channels in the vicinity of Adit No. 1 are vegetated channels with some large rocks in the bottom of the channel. The use of an erosion control mat allows the reclamation channel to look more like a natural channel. The methodology used to verify the capacity and stability of the reclamation channels is presented in Attachment 1 in this appendix.

A summary of the as-built reclamation channels is presented in Table 3.5-5AB of this appendix.

Reclamation Culvert Verification - The runoff in the reclamation channels is being conveyed under the highway by an existing 8' by 10' box culvert (ARBC-1). A 24-inch diameter culvert (ARC-1) is conveying runoff from the reclamation channel ARD-1B to the box culvert as shown on Exhibit 3.5-5AB. At the end of the box culvert the runoff will flow into Channel ARD-3,

which takes the runoff down to the Price River. Verification of the culverts capacity can be found in Attachment 1 of this appendix.

3.5-4(3)AB Alternative Sediment Control Measures

The disturbed area of the Adit No. 1 canyon has been regraded to allow stormwater runoff to overland flow to the permanent reclamation channels. The following alternative sediment control measures (ASCMs) were used in varying degrees to limit and control sediment runoff:

1. Incorporation of hay and/or straw mulch into the growth media,
2. Deep gouging of the growth media,
3. Seeding the prepared soil,
4. Addition of more mulch following seeding, and
5. Chemically or physically anchoring the final mulch layer.

These methods have been used at other reclamation sites with good success and are expected to be successful at this site. Appendix 3.5-D presents calculations that quantify the sediment yield that could be expected annually from the reclaimed area at Adit No. 1 under the following conditions:

1. Pre-mining conditions,
2. Conditions immediately following completion of seeding and mulching, and
3. Conditions several years after reclamation has occurred.

These calculations were performed to compare the improvement after implementation of the ASCMs listed above against background levels. Assumptions used for the analysis of each time period listed above are provided in Appendix 3.5-D.

As noted in the appendix, implementation of the ASCMs will substantially reduce the amount of sediment eroded from the reclaimed areas. Pre-mining erosion at the site is estimated to have occurred at a rate of 7.3 tons per acre per year. Immediately after completion of seeding and mulching, with fresh mulch on the surface of the site, erosion is estimated to occur at a rate of 0.2 tons per acre per year. Following establishment of the vegetative cover (i.e., after weathering and degradation of the mulch), the erosion rate is estimated to be 5.5 tons per acre per year. Hence, reclamation of the site will reduce soil loss below that estimated to have occurred prior to disturbance.

The reclaimed area will be inspected quarterly to evaluate the effectiveness of the ASCMs. Corrective action will be taken when a gully greater than 9 inches in depth is created. This corrective action will consist of identifying the cause, remedying the cause, working the ground surface sufficiently to fill the adjacent gully, and reseeding and mulching if necessary to reestablish vegetation. Any reseeding and mulching will be determined in cooperation with the Division.

3.5-5AB Reclamation Timeline

Demolition at the site began in early fall of 2002. Final reclamation of the site was completed in late fall of 2002. Monitoring of the site will continue until Phase III bond release.

TABLE 3.5-5AB

ADIT NO. 1 CANYON
AS-BUILT RECLAMATION DIVERSION SUMMARY

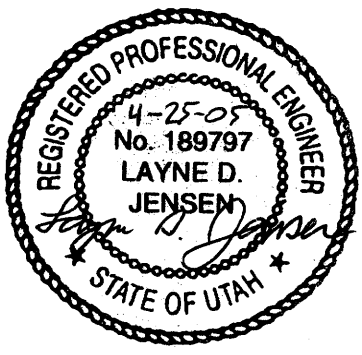
RECLAMATION DIVERSION	MIN. BOTTOM WIDTH (FT)(a)	SIDE SLOPES (H:V)	MINIMUM CHANNEL DEPTH (FT)	MINIMUM BOTTOM SLOPE (%)	MAX. FLOW DEPTH (FT)	FREEBOARD (FT)	MAXIMUM BOTTOM SLOPE (%)	MAXIMUM VELOCITY (FT/S)	CHANNEL PROTECTION
ARD-1A[(b)]	3.5	1.75:1	1.0	13.3	0.15	0.85	34.9	4.44	erosion mat
ARD-1B[(b)]	3.5	1.75:1	1.0	15.6	0.18	0.82	40.0	5.95	erosion mat
ARD-2[(b)]	2.5	1.6:1	1.25	15.6	0.11	0.89	40.0	3.72	erosion mat
ARD-3[(b)]	5.0	2.5:1	1.0	16.1	0.16	0.84	75.7	4.87	riprap D_{50}=9"

(a) Minimum bottom width measured at minimum depth from top of channel.
(b) Design based on 10-year 6-hour storm (Ephemeral drainage).

Note: The channel dimensions above represent the minimum cross-sectional flow area. The majority of the reclamation channel length has a larger cross-sectional area than indicated above.

ATTACHMENT 1

AS-BUILT RECLAMATION HYDROLOGY CALCULATIONS



As-Build Hydrology Calculations
Adit No. 1

The purpose of these calculations is to demonstrate that the constructed reclamation channels can handle the peak flow generated by the 10-year 6-hour design storm event. All channels will be shown to be capable of safely handling the design event.

To minimize confusion and ease review watersheds and channels are labeled in the same manner as found in the design calculations found in Appendix 3.5C.

Methodology

- Curve Number techniques of the U.S. SCS (1972)
- Triangular Unit Hydrograph approach of the U.S. SCS (1972) as programed by Hawkins and Marshall (1979)
- Drainage areas, slopes and hydraulic lengths determined from as-built aerial topography. See Exhibit 3.5-3A for watershed location.

Rainfall Depths

10-year 6-hour	1.4 inches
10-year 24-hour	1.8 inches

Reclamation Curve Numbers

The curve number for each watershed is determined by an area weighted average between undisturbed and reclaimed areas.

A curve number of 75 will be used for the undisturbed areas as stated in Section 3.5-3(2) of the M&RP.

A curve number of 80 will be used for reclaimed areas. This is a conservative estimate considering that the site has already revegetated well and the deep gouges will retain moisture on the slopes. Thus, not allowing runoff from the reclaimed area.

ADIT NO. 1 AS-BUILT
CURVE NUMBER SUMMARY

Watershed No.	Total Area (ac)	Undisturbed		Disturbed		Weighted CN
		Area (ac)	CN	Area (ac)	CN	
AWS-1	7.87	7.69	75	0.18	80	76
AWS-2	17.40	17.19	75	0.21	80	76
AWS-3	1.95	0.84	75	1.11	80	78

A summary of watershed characteristics can be found on the following pages.

Summary of Watershed Data

Watershed Area	Drainage Area (ac)	Curve Number	S (in)	Y (%)	I (ft)	L (hr)	Time of Conc. (hr)	Peak Flow (cfs)
AWS-1	7.87	76	3.158	64.5	1020	0.045	0.076	0.75
AWS-2	17.4	76	3.158	68.4	1350	0.055	0.092	1.57
AWS-3	1.95	78	2.821	61.6	430	0.022	0.037	0.32

Notes

Watershed locations can be found on Exhibit 3.5-3A
S = 1000/CN - 10
Y = average watershed slope = (length of contour lines)(contour interval)/(watershed area)
I = hydraulic length
L = watershed lag =(I^0.8(S+1)^0.7) / (1900(Y)^0.5)
Time of Concentration + 1.67L
Peak Flow is based on a 10-yr 6-hr storm event

Triangular Hydrograph Calculations using

SCSHYDRO Program

Watershed I.D.:
AWS-1

INPUT SUMMARY

STORM :	WATERSHED :
Dist.= SCS Type `b'	Area = 7.87 acres
Depth = 1.40 inches	CN = 76.00
Duration = 6.0 hrs	Time conc.= 0.08 hrs

OUTPUT SUMMARY

Runoff depth: 0.150 inches
Initial abstr: 0.632 inches
Peak flow: 0.75 cfs (0.095 iph)
at time: 2.523 hrs

Triangular Hydrograph Calculations using

SCSHYDRO Program

Watershed I.D.:
AWS-2

INPUT SUMMARY

STORM :	WATERSHED :
Dist.= SCS Type `b'	Area = 17.40 acres
Depth = 1.40 inches	CN = 76.00
Duration = 6.0 hrs	Time conc.= 0.09 hrs

OUTPUT SUMMARY

Runoff depth: 0.150 inches
Initial abstr: 0.632 inches
Peak flow: 1.57 cfs (0.090 iph)
at time: 2.539 hrs

Triangular Hydrograph Calculations using

SCSHYDRO Program

Watershed I.D.:
AWS-3

INPUT SUMMARY

STORM :	WATERSHED :
Dist.= SCS Type `b'	Area = 1.95 acres
Depth = 1.40 inches	CN = 78.00
Duration = 6.0 hrs	Time conc.= 0.04 hrs

OUTPUT SUMMARY

Runoff depth: 0.191 inches
Initial abstr: 0.564 inches
Peak flow: 0.32 cfs (0.160 iph)
at time: 2.506 hrs

Channel Verification

Assumptions

1. All ditches verified for the 10-yr 6-hr storm event,

2. When determining the adequacy of the riprap the method presented by Searcy, (1967) will be used,

3. Riprap thickness is twice the D_{50},

4. The Mannings n for the Pyromat channels will be determined based on the vegetation and rock currently found in the channel,

5. A flow of 0.25 cfs will be added to the peak flow in channels ARD-1A and 1B to account for the water flowing from the mine into the channel, the flow is actually much less than this flow was chosen to be conservative,

6. A Mannings n for riprap channels will be determined using the method presented by Abt, S.R., et. al. (1987)

$$n = 0.0456(D_{50} \times \text{Slope})^{0.159}$$

Where: D50 = median riprap size (inches)
Slope = (ft\ft)

The channels were measured in fall of 2004. The channels were measured at the location of the minimum flow area. Thus, the channels typically have a greater capacity than indicated in this calculation.

Channel cross-sections for each of the channels can be found on pages 21 and 22. Channel profiles can be found on Exhibit 3.5-3B.

ARD-1A

Contributing Watershed is 100% of AWS-2
Peak Flow = 1.57 x 0.25 = 1.82 cfs
Minimum Slope = 13.3%
Maximum Slope = 34.9%

Trapizoidal Ditch
Side slopes = 1.75:1
Depth = 1 ft
Bottom Width = 3.5 ft

Erosion protection = Pyromat erosion control matting
The Pyromat was covered with a layer of soil and rocks. When the channel was measured this channel had good vegetation already established. Thus, Mannings n will reflect the roughness of the rock and vegetation in the channel.

Maximum Velocity = 4.44 fps
Maximum Depth = 0.15 ft
Freeboard = 0.85 ft

See pages 11 and 12 for calculation sheets

ARD-1B

Contributing Watersheds are AWS-1, AWS-2, and AWS-3
Peak Flow = 0.75 + 1.57 + 0.32 + 0.25 = 2.89 cfs
Minimum Slope = 15.6%
Maximum Slope = 40.0%

Trapizoidal Ditch
Side slopes = 1.75:1
Depth = 1.0 ft
Bottom Width = 3.5 ft

Erosion protection = Pyromat erosion control matting
The Pyromat was covered with a layer of soil and rocks. When the channel was measured this channel had some vegetation already established. This channel has a constant flow of water from the mine and the vegetation is well established on the sides of the channel with vegetation on the the bottom of the channel being less established. Mannings n will reflect the roughness of the rock and vegetation in the channel.

Maximum Velocity = 5.95 fps
Maximum Depth = 0.18 ft
Freeboard = 0.82 ft

See pages 13 and 14 for calculation sheets

ARD-2

Contributing Watershed is AWS-1
Peak Flow = 0.75 cfs
Minimum Slope = 15.6%
Maximum Slope = 40.0%

Trapizoidal Ditch
Side slopes = 1.6:1
Depth = 1.25 ft
Bottom Width = 2.5 ft

Erosion protection = Pyromat erosion control matting
The Pyromat was covered with a layer of soil and rocks. When the channel was measured this channel had good vegetation already established. Thus, Mannings n will reflect the roughness of the rock and vegetation in the channel.

Maximum Velocity = 3.72 fps
Maximum Depth = 0.11 ft
Freeboard = 0.89 ft

See pages 15 and 16 for calculation sheets

ARD-3

Contributing Watersheds are AWS-1, AWS-2, and AWS-3
Peak Flow = 0.75 + 1.57 + 0.32 + 0.25 = 2.89 cfs
Minimum Slope = 16.1%
Maximum Slope = 75.7%

Trapizoidal Ditch
Side slopes = 2.5:1
Depth = 1.0 ft
Bottom Width = 5 ft
Riprap = 9 inch

Maximum Velocity = 4.87 fps
Maximum Depth = 0.16 ft
Freeboard = 0.84 ft

See pages 17 and 18 for calculation sheets

Culverts

ARC-1

Culvert Diameter = 24 inches

Contributing Watersheds are AWS-1, AWS-2, and AWS-3

Peak Flow = 0.75 + 1.57 + 0.32 + 0.25 = 2.89 cfs

Culvert Slope = minimum of 5 %

Culvert inlet capacity = 13.0 cfs (mitered inlet)

Culvert capacity based on minimum culvert slope = 27.40 cfs

Culvert capacity is controlled by the inlet. However, the inlet capacity is still over four times the peak flow from the 10-year 6-hour storm.

Outlet velocity = Culvert outlet is in the box culvert thus no outlet protection is needed

ARBC-1

Culvert size = 10 ft wide by 8 ft high

Contributing Watersheds are AWS-1, AWS-2, and AWS-3

Peak Flow = 0.75 + 1.57 + 0.32 + 0.25 = 2.89 cfs

Culvert Slope = 1.0 %

The box culvert will be modeled as a rectangular channel

Maximum flow velocity = 2.39 ft/sec

Maximum flow depth = 0.12 ft

Outlet protection will not be needed due to the very low flow velocity. Although unnecessary the box culvert flows into a channel with 9 inch riprap.

ARD-1A Minimum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Adit No. 1
Flow Element	Trapezoidal Cha
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.045	Rocky channel with grass and brush on bottom and sides
Slope	0.133000	ft/ft
Left Side Slope	1.75	V : H
Right Side Slope	1.75	V : H
Bottom Width	3.50	ft
Discharge	1.82	cfs

Results		
Depth	0.15	ft < 1.0' OK
Flow Area	0.6	ft²
Wetted Perim	3.85	ft
Top Width	3.68	ft
Critical Depth	0.20	ft
Critical Slope	0.055187	ft/ft
Velocity	3.30	ft/s
Velocity Head	0.17	ft
Specific Ener	0.32	ft
Froude Numb	1.50	
Flow Type	Supercritical	

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ARD-1A Maximum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Adit No. 1
Flow Element	Trapezoidal Cha
Method	Manning's Formi
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.045	
Slope	0.349000	ft/ft
Left Side Slope	1.75	V : H
Right Side Slope	1.75	V : H
Bottom Width	3.50	ft
Discharge	1.82	cfs

Rocky channel with grass and brush on bottom and sides.

Results		
Depth	0.11	ft
Flow Area	0.4	ft²
Wetted Perim	3.76	ft
Top Width	3.63	ft
Critical Depth	0.20	ft
Critical Slope	0.055186	ft/ft
Velocity	4.44	ft/s
Velocity Head	0.31	ft
Specific Energ	0.42	ft
Froude Numb	2.33	
Flow Type	Supercritical	

manufacturer of Pyramat claims protection to 10 ft/sec for an unvegetated channel ∴ OK

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ARD-1B Minimum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Adit No. 1
Flow Element	Trapezoidal Cha
Method	Manning's Formi
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.040	
Slope	0.156000	ft/ft
Left Side Slope	1.75	V : H
Right Side Slope	1.75	V : H
Bottom Width	3.50	ft
Discharge	2.89	cfs

rocky channel with brush and grass on side slopes.

Results		
Depth	0.18	ft
Flow Area	0.7	ft²
Wetted Perim	3.92	ft
Top Width	3.71	ft
Critical Depth	0.27	ft
Critical Slope	0.040553	ft/ft
Velocity	4.44	ft/s
Velocity Head	0.31	ft
Specific Ener	0.49	ft
Froude Numb	1.87	
Flow Type	Supercritical	

< 1.0 ft ∴ ok

ARD-1B Maximum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Adit No. 1
Flow Element	Trapezoidal Cha
Method	Manning's Formı
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.040	
Slope	0.400000	ft/ft
Left Side Slope	1.75	V : H
Right Side Slope	1.75	V : H
Bottom Width	3.50	ft
Discharge	2.89	cfs

rocky channel with brush and grass on side slopes.

Results		
Depth	0.14	ft
Flow Area	0.5	ft²
Wetted Perim	3.81	ft
Top Width	3.66	ft
Critical Depth	0.27	ft
Critical Slope	0.040553	ft/ft
Velocity	5.95	ft/s
Velocity Head	0.55	ft
Specific Energ	0.69	ft
Froude Numb	2.88	
Flow Type	Supercritical	

< 10.0 fps $\therefore$ ok

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ARD-2 Minimum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Adit No. 1
Flow Element	Trapezoidal Cha
Method	Manning's Formi
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.045	
Slope	156000	ft/ft
Left Side Slope	1.60	V : H
Right Side Slope	1.60	V : H
Bottom Width	2.50	ft
Discharge	0.75	cfs

rocky channel with grass and brush on the channel bottom and sides.

Results		
Depth	0.11	ft
Flow Area	0.3	ft²
Wetted Perim	2.75	ft
Top Width	2.63	ft
Critical Depth	0.14	ft
Critical Slope	0.062037	ft/ft
Velocity	2.78	ft/s
Velocity Head	0.12	ft
Specific Ener	0.23	ft
Froude Numb	1.53	
Flow Type	Supercritical	

< 1.25 ok

ARD-2 Maximum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Adit No. 1
Flow Element	Trapezoidal Cha
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.045	
Slope	400000	ft/ft
Left Side Slope	1.60	V : H
Right Side Slope	1.60	V : H
Bottom Width	2.50	ft
Discharge	0.75	cfs

rocky channel w/ grass and brush on bottom and sides

Results		
Depth	0.08	ft
Flow Area	0.2	ft²
Wetted Perim	2.69	ft
Top Width	2.60	ft
Critical Depth	0.14	ft
Critical Slope	0.062034	ft/ft
Velocity	3.72	ft/s
Velocity Head	0.21	ft
Specific Energ	0.29	ft
Froude Numb	2.35	
Flow Type	Supercritical	

< 10 fps ∴ ok

ARD-3 Minimum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Adit No. 1
Flow Element	Trapezoidal Cha
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.048	
Slope	161000	ft/ft
Left Side Slope	2.50	V : H
Right Side Slope	2.50	V : H
Bottom Width	5.00	ft
Discharge	2.89	cfs

$D_{50} = 9''$ Slope = 16.1%

$n = 0.456 (9'' \times 0.161)^{0.159} = 0.048$

riprap D_{50} (in)

Slope $\left(\frac{ft}{ft}\right)$

Abt, et. al (1987)

Results		
Depth	0.16	ft
Flow Area	0.8	ft²
Wetted Perim	5.35	ft
Top Width	5.13	ft
Critical Depth	0.22	ft
Critical Slope	0.061246	ft/ft
Velocity	3.53	ft/s
Velocity Head	0.19	ft
Specific Ener	0.36	ft
Froude Numb	1.56	
Flow Type	Supercritical	

< 1.0' OK

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ARD-3 Maximum Slope
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Adit No. 1
Flow Element	Trapezoidal Cha
Method	Manning's Form
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.062	
Slope	757000	ft/ft
Left Side Slope	2.50	V : H
Right Side Slope	2.50	V : H
Bottom Width	5.00	ft
Discharge	2.89	cfs

$D_{75} = 9''$ Slope = 75.7%

Results		
Depth	0.12	ft
Flow Area	0.6	ft²
Wetted Perim	5.25	ft
Top Width	5.09	ft
Critical Depth	0.22	ft
Critical Slope	0.100921	ft/ft
Velocity	4.87	ft/s
Velocity Head	0.37	ft
Specific Energ	0.49	ft
Froude Numb	2.52	
Flow Type	Supercritical	

< 9 fps ∴ ok

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ARC-1
Worksheet for Circular Channel

Project Description	
Worksheet	ADIT NO. 1 CU
Flow Element	Circular Channe
Method	Manning's Forr
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.024	
Slope	050000	ft/ft
Diameter	24	in
Discharge	2.89	cfs

Results		
Depth	0.44	ft
Flow Area	0.5	ft²
Wetted Perime	1.95	ft
Top Width	1.66	ft
Critical Depth	0.59	ft
Percent Full	21.9	%
Critical Slope	0.015186	ft/ft
Velocity	5.66	ft/s
Velocity Head	0.50	ft
Specific Energ	0.94	ft
Froude Numbe	1.80	
Maximum Disc	29.47	cfs
Discharge Full	27.40	cfs
Slope Full	0.000556	ft/ft
Flow Type	Supercritical	

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ARBC-1
Worksheet for Rectangular Channel

Project Description	
Worksheet	Box Culvert
Flow Element	Rectangular Cha
Method	Manning's Formu
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.015	
Slope	010000	ft/ft
Bottom Width	10.00	ft
Discharge	2.89	cfs

Results		
Depth	0.12	ft
Flow Area	1.2	ft²
Wetted Perim	10.24	ft
Top Width	10.00	ft
Critical Depth	0.14	ft
Critical Slope	0.006587	ft/ft
Velocity	2.39	ft/s
Velocity Head	0.09	ft
Specific Energ	0.21	ft
Froude Numb	1.21	
Flow Type	Supercritical	

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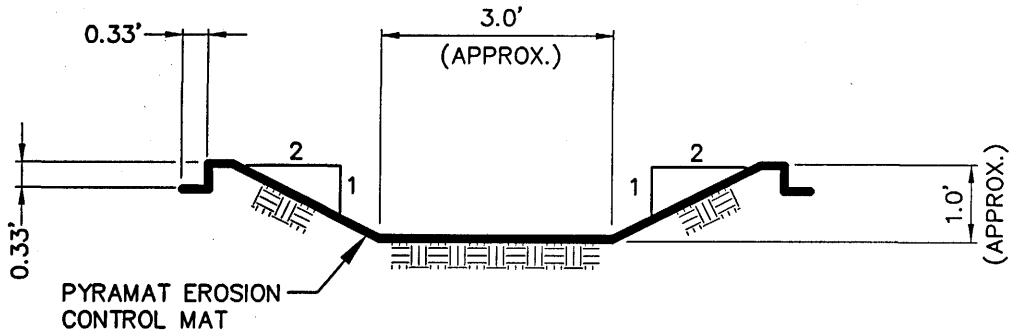
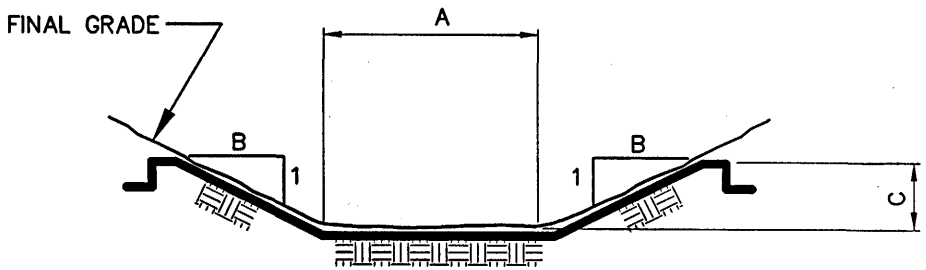


TYPICAL UNCOVERED PYRAMAT CHANNEL
NO SCALE



CHANNEL	A (ft)	B (ft)	C (ft)
ARD–1A	3.5	1.75	1.0
ARD–1B	3.5	1.75	1.0
ARD–2	2.5	1.60	1.25

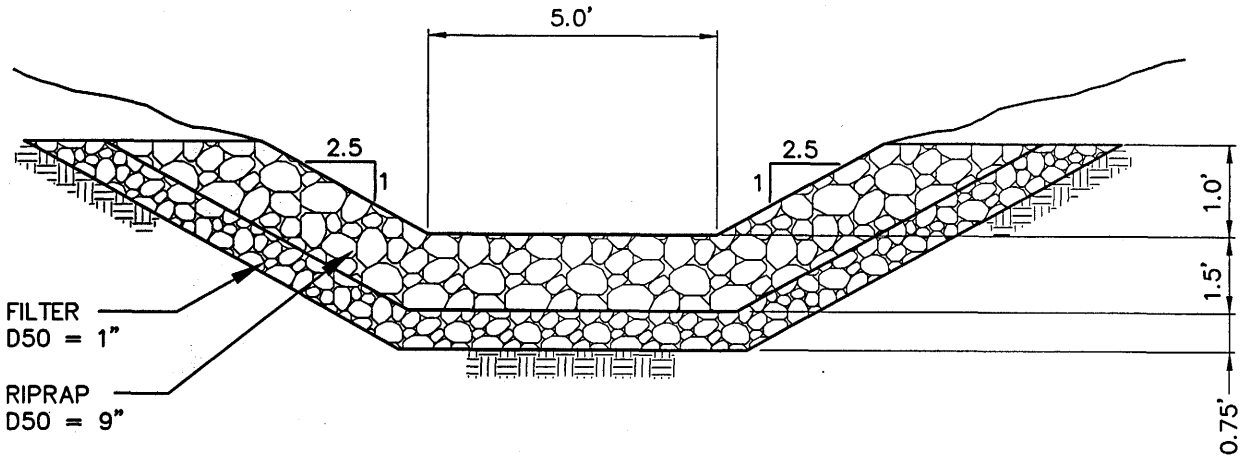
AS–BUILT COVERED PYRAMAT CHANNEL
NO SCALE

NO SCALE

ARD–1A, ARD–1B AND ARD–2

EarthFax

G:\UC709\25\DWG\FIG–ARD–1AND2.DWG



NO SCALE

ARD–3

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High Performance Turf Reinforcement Mat

The Fourth Dimension in Soft Armor

- Streambank and Shoreline Stabilization
- Landfill Slopes and Channels
- Wrapped-Face Slopes
- Coastral Protection
- Inland Waterways
- Inlet/Outlet Protection

SI® Geosolutions

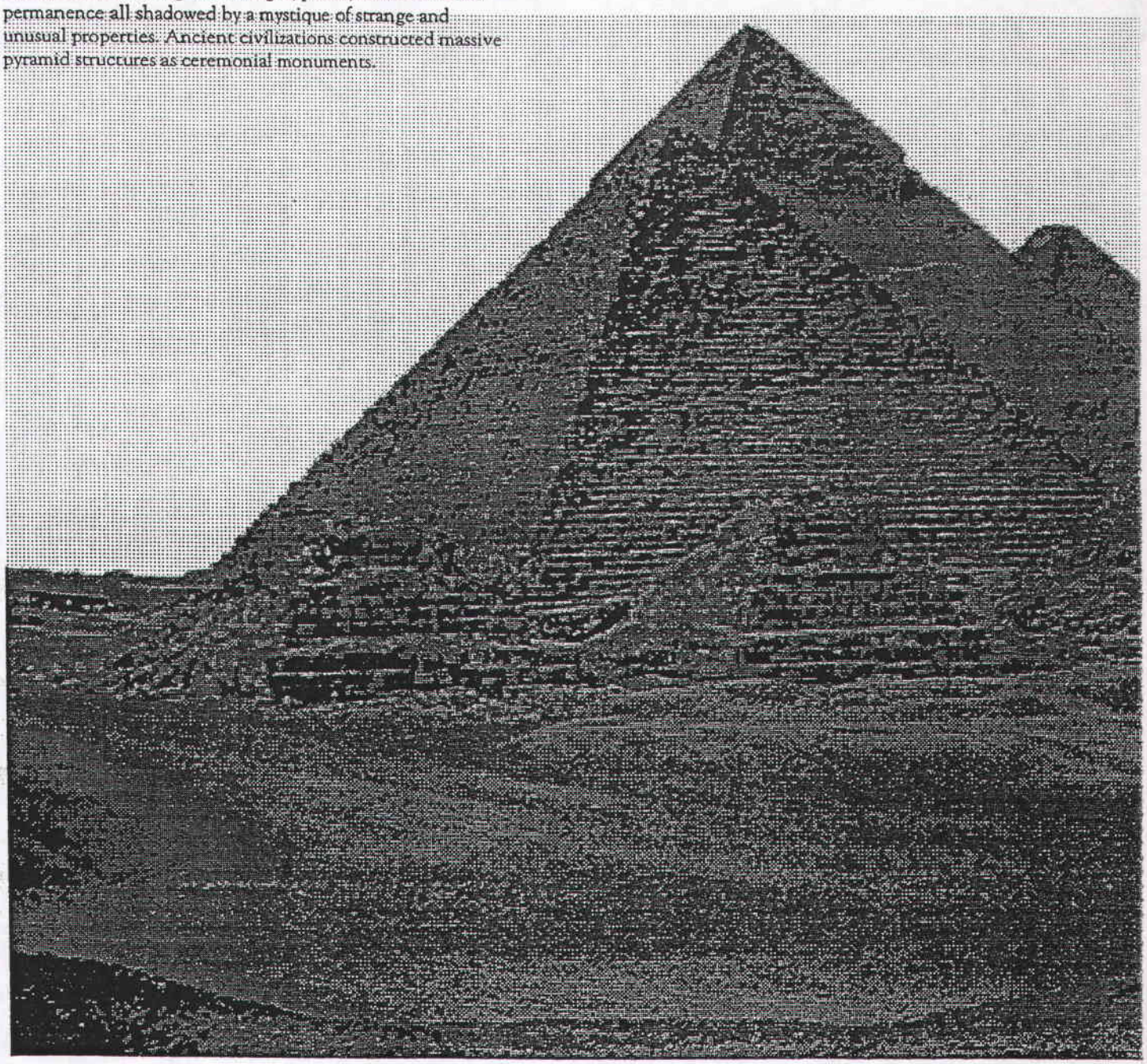
The Mystery of the Pyramids

Pyr-a-mid \ 'pir-ə-mid \ n [L *pyramid-*, *pyramis*, fr. Gk. of unknown origin] (1549) 1 a: an ancient massive structure found esp. in Egypt having typically a square ground plan, outside walls in the form of four triangles that meet in a point at the top, and inner sepulchral chambers b: a structure or object of similar form.

Throughout the sands of time, the word "pyramid" has brought to mind images of strength, power, dominance and permanence all shadowed by a mystique of strange and unusual properties. Ancient civilizations constructed massive pyramid structures as ceremonial monuments.

Thousands of years later, these structures remain intact. Scholars still attempt to comprehend and chronicle the enigmatic history, construction and often inexplicable properties of these highly efficient structures.

Pyramids have truly stood the test of time.



The Matrix of Pyramids

Bi-o-tech-ni-cal com-pos-ite® \ bī-ō-'tek-ni-kəl käm-'päz-ət \ n (1991) the synergistic, mutually beneficial union of living plant tissue and structurally integrated geosynthetic materials to provide permanently enhanced erosion protection and stability.

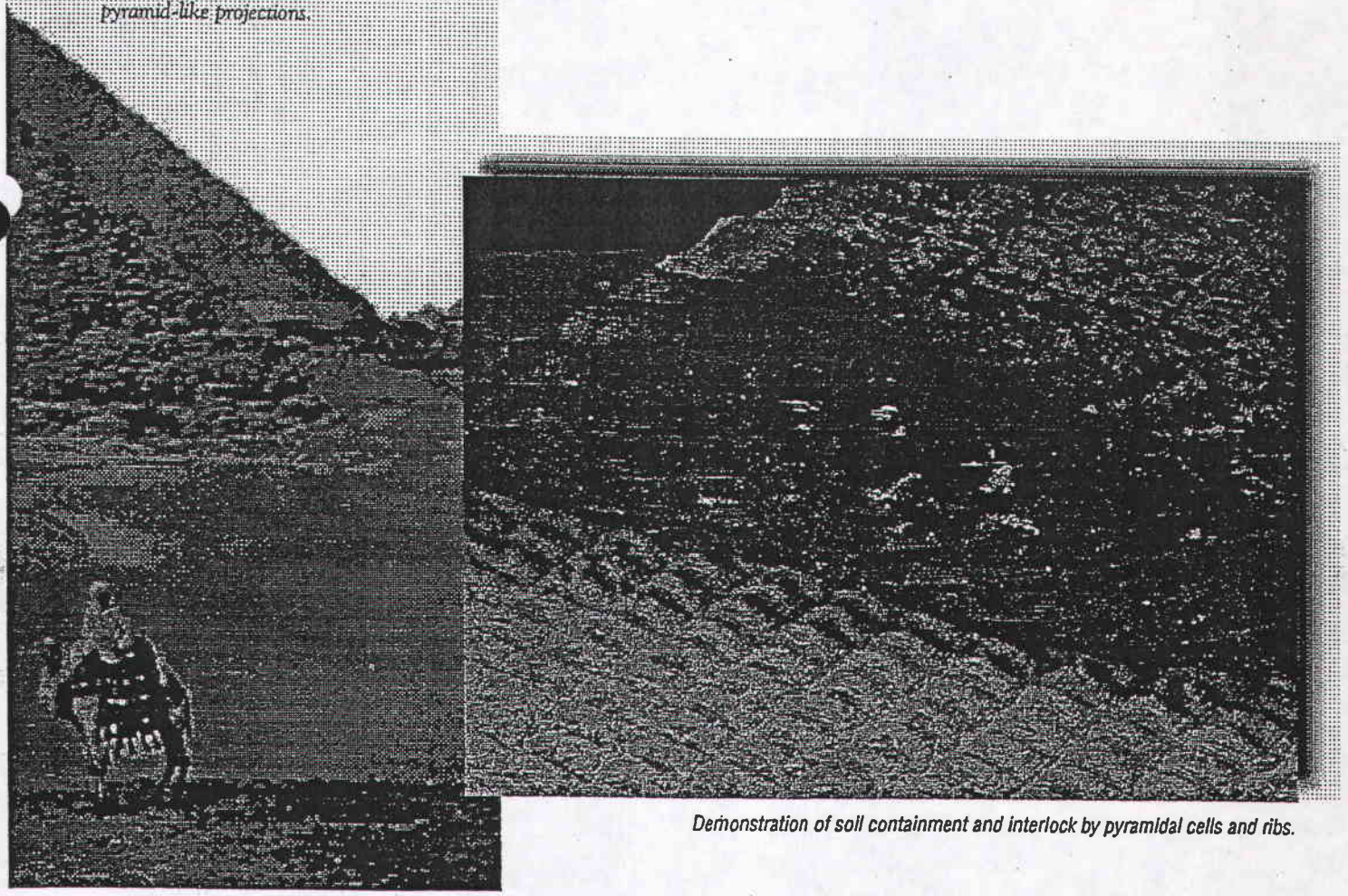
Through the years, flexible soft armor techniques have emerged as proven and preferred alternatives to traditional hard erosion control approaches emphasizing expensive and unattractive rock, concrete and structural materials. Yet many designers have been hesitant to employ environmentally superior soft solutions due to concerns regarding their retained strength, durability and performance through *time, the fourth dimension.*

Focused on superior, long-term performance, designers at SI® Geosolutions have created Pyramat® high performance turf reinforcement mat. This patented, *three-dimensional woven geotextile matrix* is composed of UV stabilized polypropylene monofilament yarns woven into a dimensionally stable, uniform configuration of resilient *pyramid-like projections.*

Using a novel and highly sophisticated weaving process all yarns are locked in place to create a unique turf reinforcement mat which exceeds the vegetal reinforcement capabilities of conventional *biotechnical composites* and combines the long-term strength, dimensional stability, durability and functional longevity of a *high performance geotextile.*

The efficient geometry of Pyramat erosion matrix helps stabilize soils and reinforce vegetation. Upward and downward protruding "pyra-cells" capture and contain soil while the multiple layers of gridlike "pyra-ribs" interlock with surrounding soils.

In addition, close inspection of the lofty matrix will reveal "hidden chambers" which literally entomb soils, even under high flow conditions. Pyramat *high performance turf reinforcement mat* (HP-TRM) is the product for demanding erosion control applications – where reinforcement of vegetation is desired to replace hard armor and increase soil stability.



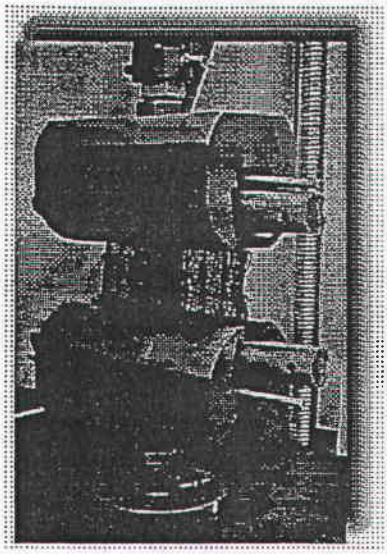
Demonstration of soil containment and interlock by pyramidal cells and ribs.

Pyramid Power

Pyramat® high performance turf reinforcement mat is a precise, highly engineered product possessing the optimal qualities for *geobotanical reinforcement*. Unparalleled strength and dimensional stability in an open, three-dimensional geotextile designed to nurture and reinforce vegetation, makes Pyramat the ultimate "new generation" turf reinforcement mat.

Part of the Landlok® family of erosion control products, Pyramat provides many times the strength of popular Turf Reinforcement Mats (TRMs) currently available. The tensile properties of Pyramat even exceed those of many conventional, two-dimensional geotextiles and geogrids. Moreover, the strength of Pyramat is distributed over three dimensions.

Direct shear and pullout testing has demonstrated that Pyramat's three-dimensional structure has a very high coefficient of friction with soils. A high interface shearing resistance makes Pyramat erosion matrix an ideal material to stabilize coast lines, embankments and landfill caps. Once emerging roots of the developing vegetation reach the zone of reinforcement, the resulting revegetation platform will provide increased slope stability and erosion control on critical sites.

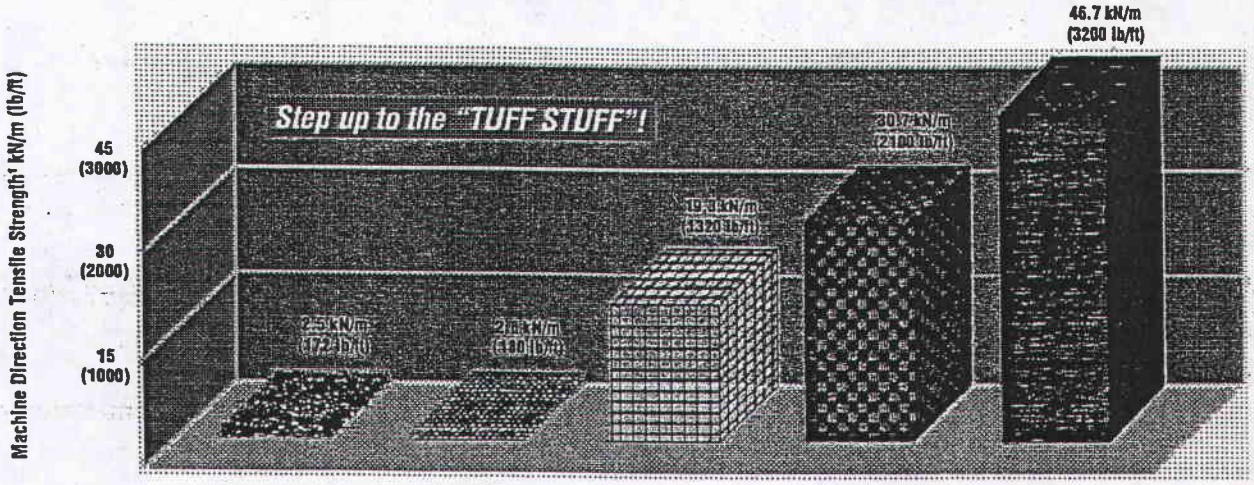


Wide width tensile testing of Pyramat®.

The abrasion resistant, resilient Pyramat structure also provides maximum resistance to construction and maintenance induced stresses. Field surveys have demonstrated that low strength mattings may sustain mechanical damage and rutting from passes of maintenance (mowing), emergency, service and recreational vehicles.

Pyramat provides greater tensile properties than an AASHTO M288-99*, Class 1, Stabilization Geotextile, ensuring protection from both anticipated and unanticipated abuse.

PUBLISHED TENSILE STRENGTHS FOR GEOSYNTHETIC MATERIALS



1 Minimum average roll values; wide width tensile test per ASTM D-4595

2 Manufacturer only publishes typical values

* AASHTO is an acronym for the American Association of State Highway Transportation Officials

The Performance Pyramid

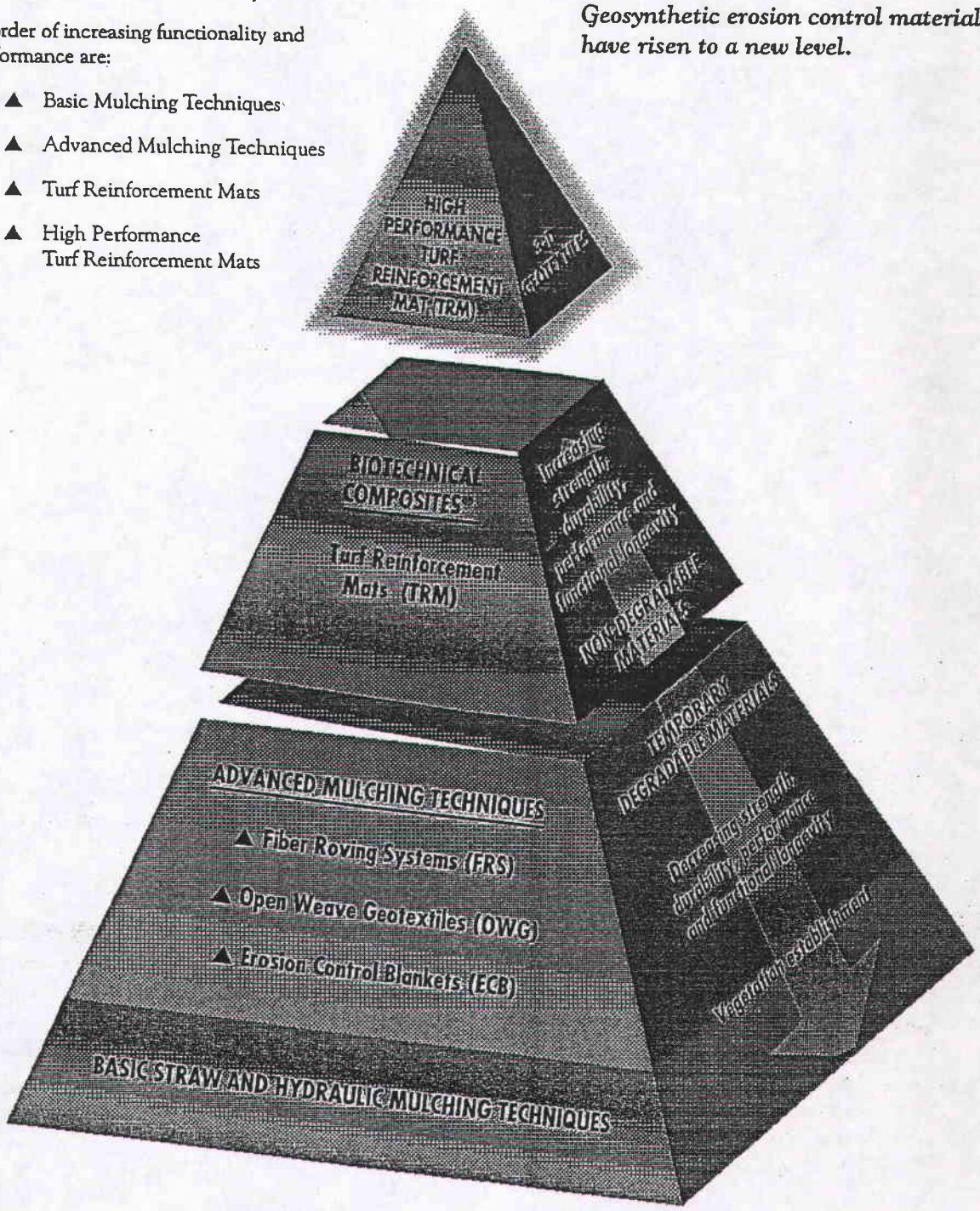
The erosion and sediment control industry has rapidly evolved into a diverse hierarchy of cost-effective methods and techniques. The adjacent *Performance Pyramid* highlights the four primary divisions of vegetated erosion control techniques.

In order of increasing functionality and performance are:

- ▲ Basic Mulching Techniques
- ▲ Advanced Mulching Techniques
- ▲ Turf Reinforcement Mats
- ▲ High Performance Turf Reinforcement Mats

Superior tensile properties combined with rugged construction, durability, proven performance and unsurpassed functional longevity clearly separate the high survivability Pyramat® from existing TRMs.

Geosynthetic erosion control materials have risen to a new level.



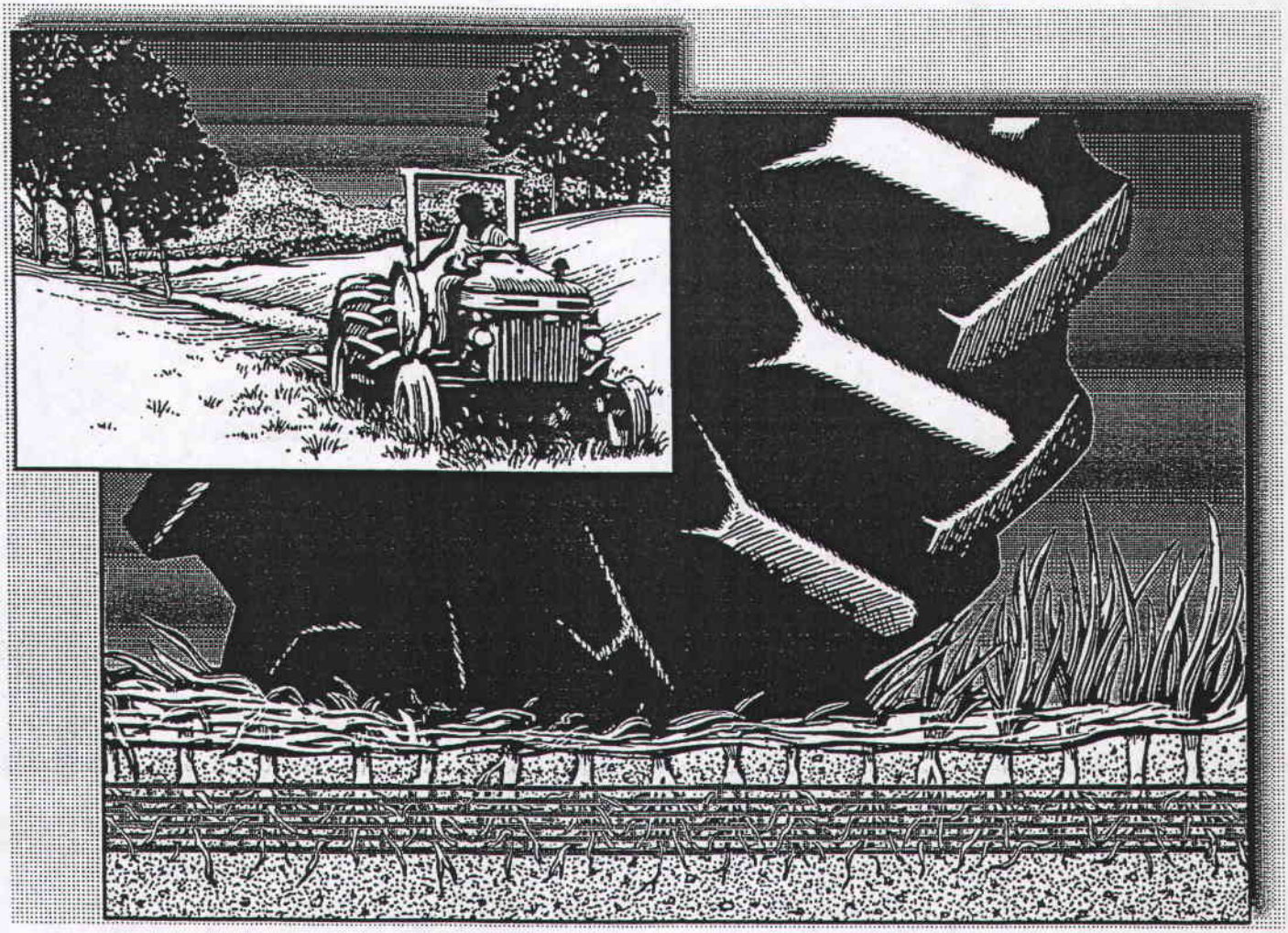
Functional Longevity for the Ages

Reinforcement matrices must provide long-term performance under adverse conditions. In arid to semi-arid regions or sites where establishment of vegetation is slow, inadequately stabilized TRMs may undergo significant UV degradation prior to performing their primary function.

The durable Pyramat® erosion matrix is designed to withstand prolonged exposure in the challenging conditions of demanding jobsites or inhospitable climates. Ultraviolet stabilizers assure functional longevity when vegetative establishment is delayed or the matrix is otherwise exposed to extended periods of sunlight.

Pyramat's polypropylene yarns are resistant to biodegradation and unaffected by chemicals normally found in soils. Some polymers, such as moisture absorbing polyamides (nylon), may be subject to temporary and permanent loss of strength from both chemical and hydrolytic attack. Because polyolefins (polypropylene) absorb negligible amounts of water, Pyramat will maintain its tensile properties under saturated conditions with no long-term loss of strength via hydrolysis.

This corrosion resistant matrix will endure as a key component of a shoreline protection system, even in brackish or salt water conditions. Careful polymer selection, high strength, resiliency, abrasion and puncture resistance, and unsurpassed dimensional stability ensure *these pyramids will also stand the test of time*.



Pyramat® high performance TRM provides "rebar for root systems."

Peak Performance

Performance of Pyramat® erosion matrix has been extensively evaluated at two renowned hydraulics testing laboratories in the western United States.

Establishing a flow rate versus time continuum, performance (see graph below) has been quantified using vegetated and non-vegetated mattings versus nonreinforced vegetation and bare soil. These studies identify the design window which provides performance guidelines from time of installation, transitioning to a mature vegetated condition for the long-term design life of the project.

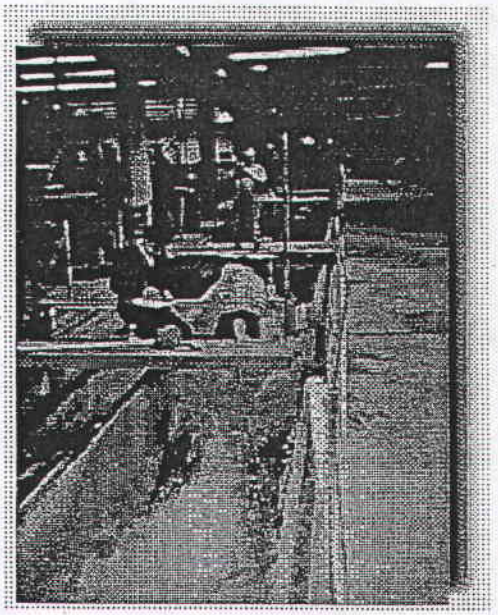
Maximum recommended permissible velocities and shear stresses for Pyramat are presented in the table above. Vegetated, Pyramat will resist flow velocities of up to 7.6 m/sec (25 ft/sec) at shear stresses up to 48.9 kg/m² (10 lb/ft²).

Additionally, the resistance of unvegetated Pyramat to directly applied shear stresses was measured using a specially designed flume. The Pyramat three-dimensional structure resisted the maximum shear developed at full-flume capacity with no deformation whatsoever. Maximum shear stress developed was approximately 39.2 kg/m² (8 lb/ft²) at a velocity of 6.1 m/sec (20 ft/sec).

The graph below illustrates the enhanced performance of Pyramat high performance turf reinforcement mat above that of conventional *Biotechnical Composites*® and natural vegetation.

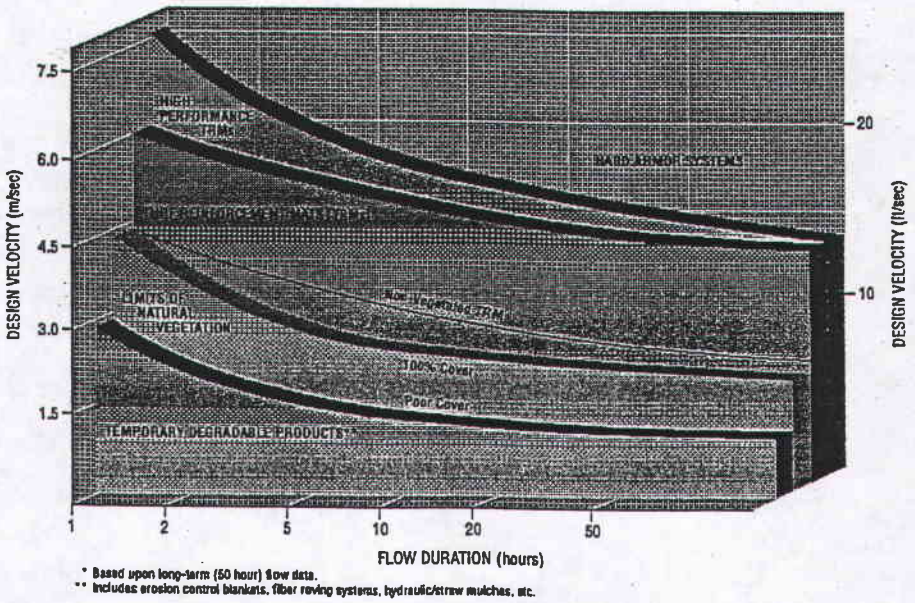
PYRAMAT® MAXIMUM PERMISSIBLE DESIGN VALUES

PERFORMANCE	SHORT-TERM (½ hr)	LONG-TERM (50 hrs)
VELOCITY		
Vegetated	7.6 m/sec (25 ft/sec)	4.3 m/sec (14 ft/sec)
Unvegetated	6.1 m/sec (20 ft/sec)	3.0 m/sec (10 ft/sec)
SHEAR STRESS		
Vegetated	48.9 kg/m² (10 lb/ft²)	29.3 kg/m² (6 lb/ft²)
Unvegetated	39.2 kg/m² (8 lb/ft²)	14.7 kg/m² (3 lb/ft²)



High velocity hydraulic flume testing.

LONG-TERM PERFORMANCE GUIDELINES*



* Based upon long-term (50 hour) flow data.
** Includes erosion control blankets, fiber roving systems, hydraulic/straw mulches, etc.

Pyramat® high performance TRM (HP-TRM) takes turf reinforcement to unprecedented levels.

PYRAMAT® Applications

Pyramat® handles a broad range of discriminating biotechnical applications requiring vegetated soil reinforcement and stabilization including:

- ▲ Stormwater/Drainage High Flow Channels
- ▲ Landfill Caps, Slopes & Diversion Structures
- ▲ Dam, Dike & Levee Protection
- ▲ Bank & Shoreline Stabilization
- ▲ Geosynthetic Reinforced Earth Structures
- ▲ Vegetated Geotextile Slope Facings
- ▲ Veneer Cover Soil Stabilization
- ▲ Inlet/Outlet Protection

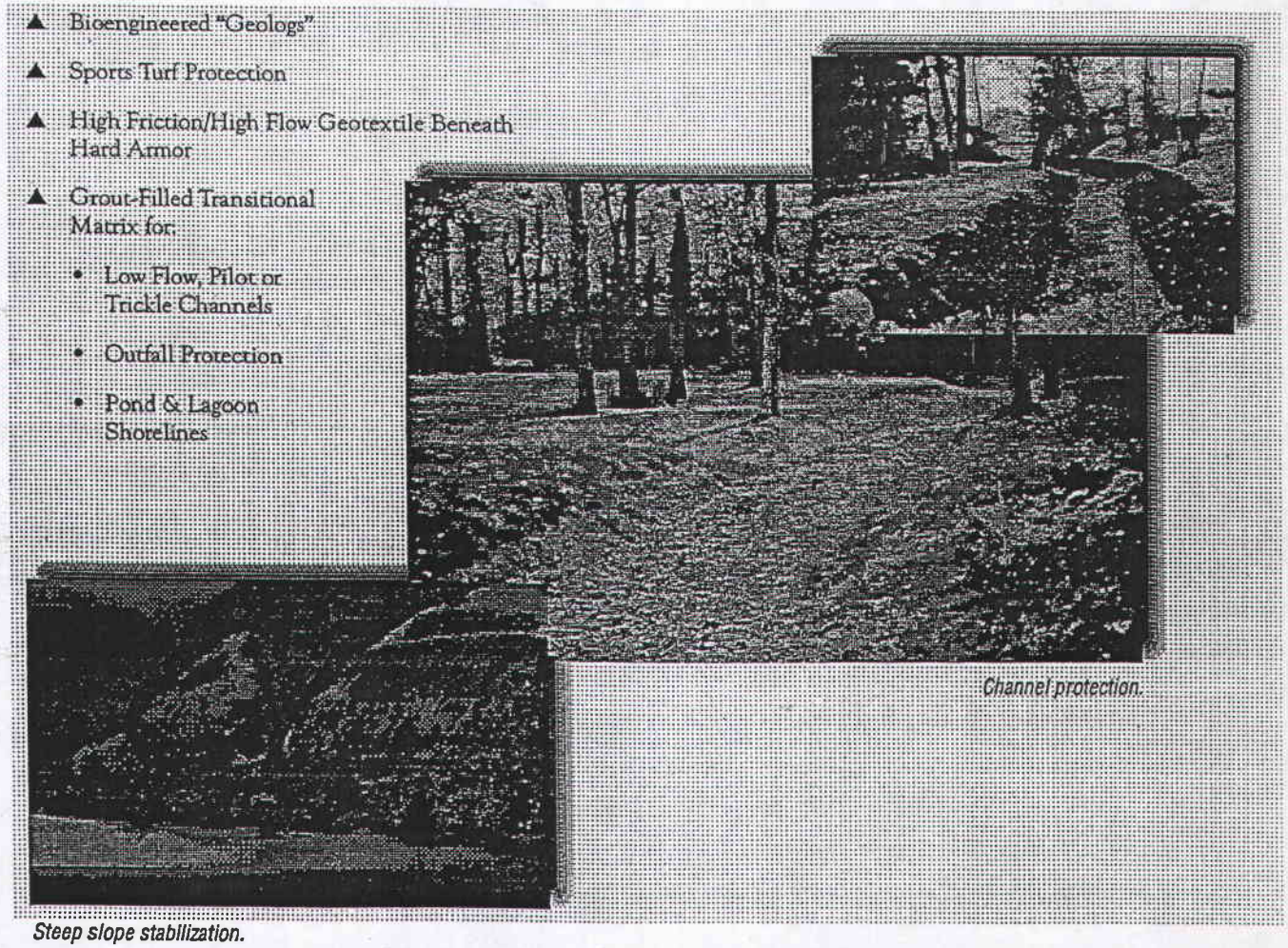
Other potential applications include:

- ▲ Grassed Access Roads/Temporary Parking Areas
- ▲ Pre-grown Reinforced Vegetated Carpets
- ▲ Bioengineered "Geologs"
- ▲ Sports Turf Protection
- ▲ High Friction/High Flow Geotextile Beneath Hard Armor
- ▲ Grout-Filled Transitional Matrix for:
  - Low Flow, Pilot or Trickle Channels
  - Outfall Protection
  - Pond & Lagoon Shorelines

PYRAMAT® Installation

The rugged Pyramat matrix will also absorb considerable installation stress permitting the use of mechanical equipment. The matrix will perform best when installed beneath the soil surface.

- ▲ When used as a vegetative reinforcement matrix, the product should be installed first, seeded, then a ½" – 1" veneer of soil placed and compacted into the "pyra-cells."
- ▲ Light weight wheeled equipment or vibratory tampers may be carefully utilized to facilitate compaction.
- ▲ Refer to the Synthetic Industries Pyramat Installation instructions as a soil-filled matrix.
- ▲ For other installation requirements, please contact SI® Geosolutions for prompt recommendations and on-site construction assistance at (423) 899-0444 or toll free in the USA at (800) FIX-SOIL.



Channel protection.

Steep slope stabilization.

Engineering Specifications

The HIGH PERFORMANCE TURF REINFORCEMENT MAT shall be a three-dimensional, lofty, woven polypropylene geotextile specially designed for erosion control applications on steep slopes, water containment structures and vegetated waterways. The matrix shall be composed of polypropylene monofilament yarns woven into a uniform, dimensionally stable configuration of resilient pyramid-like projections. The material shall exhibit very high interlock and reinforcement capacity with both soil and root systems and demonstrate high tensile modulus. The high performance TRM shall conform to the property values listed below under dry or saturated conditions.

		MINIMUM AVERAGE ROLL VALUES (MARV)	
PROPERTY	**TEST METHOD**	**ENGLISH**	**METRIC**
MECHANICAL			
Tensile Strength[2]	ASTM D-4595	3,200 X 2,200 lb/ft	46.7 X 32.1 kN/m
	ASTM D-5035	3,100 X 2,000 lb/ft	45.2 X 29.2 kN/m
Tensile Elongation[2]	ASTM D-4595	80% (max)	80% (max)
	ASTM D-5035	55% (max)	55% (max)
ENDURANCE			
UV Resistance @ 1000 hours	ASTM D-4355	80%	80%
PHYSICAL			
Thickness	ASTM D-1777	0.5 in	12.7 mm
Resiliency[3]	ASTM D-1777	80%	80%
Mass Per Unit Area	ASTM D-5621	14 oz/yd²	475 g/m²
Ground Cover Factor[4]	Light Projection Analysis	75%	75%

PERFORMANCE	**MAXIMUM PERMISSIBLE VALUES**			
Velocity	Short-Term (½ hr)		Long-Term (50 hrs)	
Vegetated	25 ft/sec	7.6 m/sec	14 ft/sec	4.3 m/sec
Unvegetated	20 ft/sec	6.1 m/sec	10 ft/sec	3.0 m/sec
Shear Stress				
Vegetated	10 lb/ft²	48.9 kg/m²	6 lb/ft²	29.3 kg/m²
Unvegetated	8 lb/ft²	39.2 kg/m²	3 lb/ft²	14.7 kg/m²

NOTES:

1 *All published values are Minimum Average Roll Values (MARV) unless otherwise indicated, yielding a 95% confidence level. Additional property values available upon request.*

2 *Values for both machine and cross machine directions under dry or saturated conditions.*

3 *Resiliency defined as percent of original thickness retained after 3 cycles of a 100 psi load (690 kPa) for 60 seconds without load... thickness measured 30 minutes after load removed in accordance with ASTM D-1777.*

4 *Ground Cover Factor represents "% shade" from Lumite® Light Projection Test.*

5 *Values obtained at an independent hydraulics testing laboratory.*

STANDARD ROLL SIZE INFORMATION

2.59 m x 27.4 m = 71 m²

8.5 ft x 90 ft = 765 ft² = 85 yd²

EC-DESIGN® 2000

EC-DESIGN® 2000, SI's newest erosion control computer software, lets users select the most appropriate erosion control product for a variety of channel and slope applications. The calculations follow state-of-the-practice U.S. Federal Highway Administration (FHWA) and Department of Agriculture (USDA) procedures, including maximum velocity and shear stress analyses, integration of compound channels, soil loss estimations and pull-down window screens. Once the most appropriate product is selected, the results, specifications and CAD drawings are printed or can be saved electronically.

EC-DESIGN 2000 offers these important features:

- ▲ Channel lining design
- ▲ Slope protection design analysis
- ▲ Maximum permissible velocity and shear stress approaches
- ▲ Integration of compound flexible channel lining systems
- ▲ Interactive cost analysis for channels and slopes

Specify the best with total confidence.

SMART SOLUTIONS®

Analyzing and solving civil and environmental problems is our focus. We want to work with you on your next project.

FOR ADDITIONAL INFORMATION, PLEASE CALL:

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- GEOTEX® woven and nonwoven geotextiles
- GEOTEX® structural soil reinforcement geotextiles and geotextile tubes
- PAVE-DRY® asphalt overlay fabrics
- LANDLOK® turf reinforcement mats, erosion control blankets and fiber roving systems
- LANDLOK® natural erosion control blankets
- PYRAMAT® high performance turf reinforcement mat
- GEOFIBERS® 3-dimensional soil reinforcement fibers
- FIBERMESH® synthetic fibers for concrete reinforcement
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Earthstopping Solutions™

Pyramat® Earthstopping Solutions

High Performance Turf Reinforcement Mat

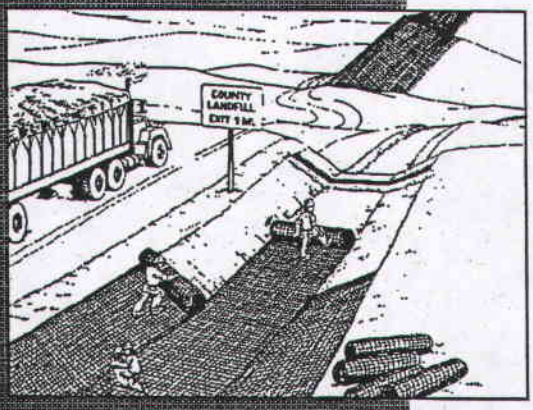
Installation Guidelines

Site Preparation

- Grade and compact area of installation.
- Prepare seedbed by loosening 50-75 mm (2-3 in) of topsoil above final grade.
- Incorporate amendments such as lime and fertilizer into soil.
- Remove all rocks, clods, vegetation or other obstructions so that the installed Pyramat® will have direct contact with soil surface.
- Do not mulch areas where mat is to be placed.

Seeding

- Apply seed to the soil surface before installing Pyramat or after installation for enhanced performance prior to soil filling (preferable).
- When seeding prior to Pyramat installation, all check slots and other areas disturbed must also be reseeded.
- When soil filling, seed Pyramat and entire disturbed area after installation, prior to filling mat with soil.
- Contact your local U.S. Natural Resource Conservation Service (NRCS) Plant Materials Specialist or other resource for seed recommendations.



PYRAMAT® Placement: Banks and Slopes

- Extend Pyramat 600-900 mm (2-3 ft) over crest of slope and excavate a 300 x 150 mm (12 x 6 in) terminal anchor trench (Figure 4 on page 3).
- Anchor Pyramat in trench on 300 mm (1 ft) spacings, backfill and compact soil.
- Unroll Pyramat down slope.
- Overlap adjacent rolls at least 75 mm (3 in) and anchor every 450 mm (18 in).
- Lay Pyramat loose to maintain direct contact with soil. (Do not pull Pyramat taut. This may allow bridging of soil surface.)
- Secure Pyramat to ground surface using U-shaped wire staples (preferred) geotextile pins. (See ground anchoring devices on page 3.)
- Refer to anchor pattern guide on page 3 for appropriate number and pattern of anchors.

SI® Geosolutions

PYRAMAT® Placement: Channels

- Excavate an initial anchor trench 300 mm (12 in) deep and 150 mm (6 in) wide across the channel at the lower end of the project area (Figure 1).
- Excavate intermittent check slots 150 mm (6 in) deep and 150 mm (6 in) wide across the channel at 9.1 m (30 ft) intervals along the channel (Figure 2).
- Cut longitudinal channel anchor slots 100 mm (4 in) deep and 100 mm (4 in) wide along both sides of the installation to bury edges of Pyramat® (Figure 3). Whenever possible, extend mat 600-900 mm (2-3 ft) above crest of channel side slopes.

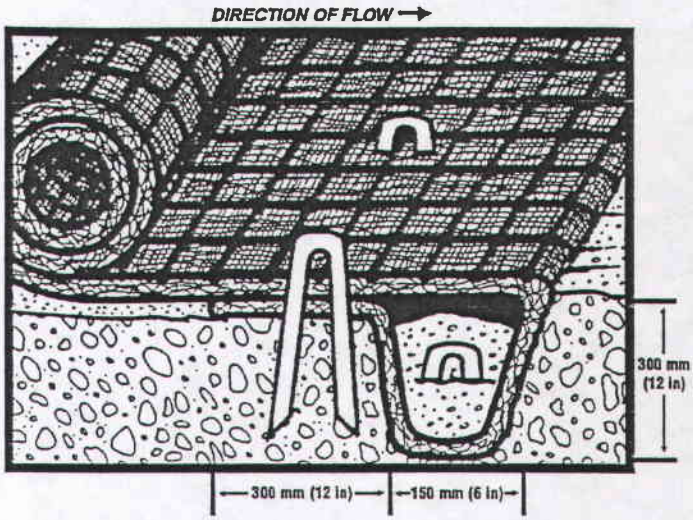


Figure 1: Initial Anchor Trench (Channels)

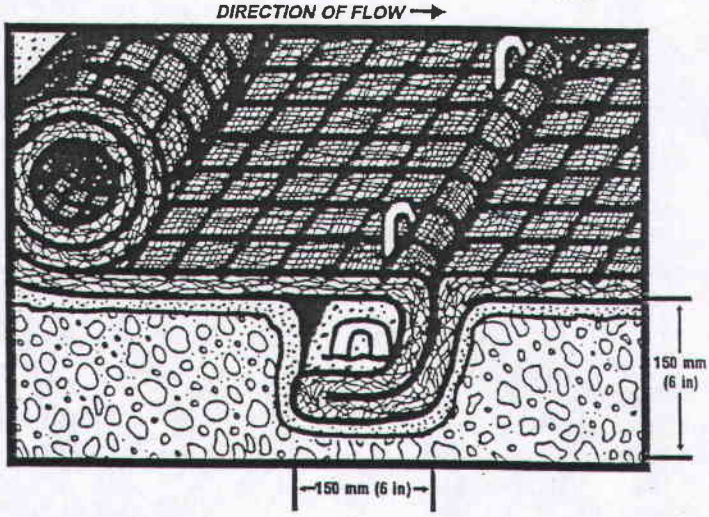


Figure 2: Intermittent Check Slot (Channels)

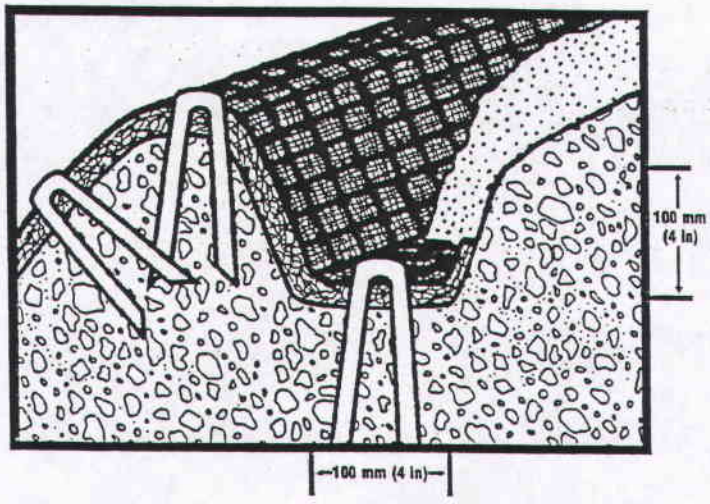


Figure 3: Longitudinal Anchor Trench (Channels)

- Beginning at the center of downstream end of the channel, place the end of the first roll in the anchor trench and secure with fastening devices at 300 mm (1 ft) intervals (Figure 1).
- In same manner, position adjacent rolls in anchor trench, overlapping the preceding roll a minimum of 75 mm (3 in).
- Again, secure at 300 mm (1 ft) intervals, backfill and compact soil.
- Unroll Pyramat over the compacted trench. Stop at next check slot or terminal anchor trench.
- Unroll adjacent rolls upstream in order to maintain a 75 mm (3 in) overlap and anchoring every 450 mm (18 in).
- Fold and secure all Pyramat rolls snugly into intermittent check slots. Lay Pyramat in the bottom and fold back against itself. Anchor through both layers of mat at 300 mm (1 ft) intervals then backfill and compact soil (Figure 2). Continue rolling Pyramat upstream over the compacted slot to the next check slot or terminal anchor trench.
- In low velocity channels of < 2.5 m/sec (< 8.2 ft/sec) excavated in cohesive soils, an alternate method may be used: place two rows of anchors on 150 mm (6 in) centers at 9.1 m (30 ft) intervals in lieu of excavated check slots.
- Overlap roll ends a minimum of 300 mm (1 ft) with upstream Pyramat on top. Begin all new rolls in a check slot. Anchor overlapped area by placing two rows of anchors, 300 mm (1 ft) apart on 300 mm (1 ft) intervals.
- Place outer edge of Pyramat in previously excavated longitudinal slots, anchor using prescribed staple pattern, backfill and compact soil (Figure 3).

- Anchor, backfill and compact upstream end of Pyramat® in a 300 x 150 mm (12 x 6 in) terminal trench (Figure 4).
- Secure Pyramat to ground surface using U-shaped wire staples (preferred) geotextile pins. (See ground anchoring devices below.)
- Refer to anchor pattern guide below for appropriate number and pattern of anchors.
- Seed and fill Pyramat with soil for enhanced performance.
- When using Pyramat with a geotextile underneath, always seed after installing mat, then fill with soil.

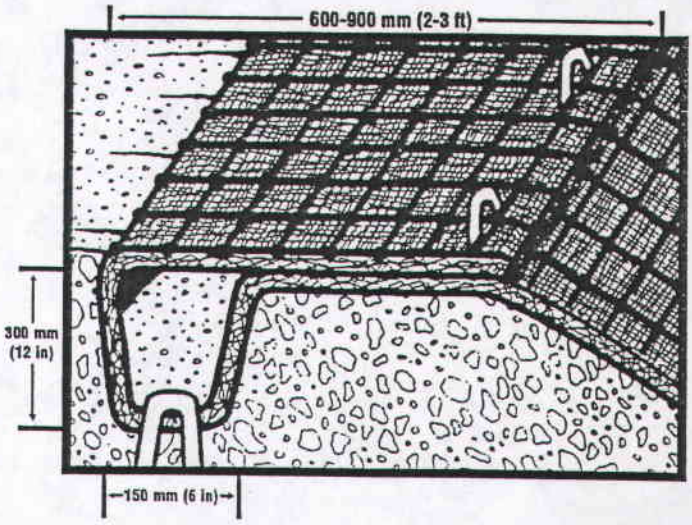


Figure 4: Terminal Anchor Trench (Slopes and Channels)

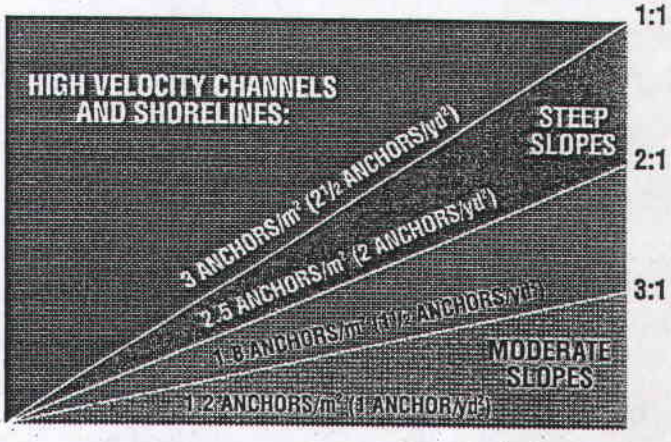
Ground Anchoring Devices

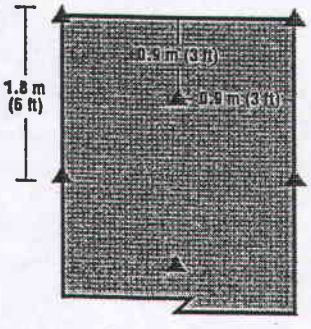
U-shaped wire staples, metal geotextile pins or plastic stakes can be used to anchor Pyramat to the ground surface. Wire staples should be a minimum of 4.3 mm (8 gauge). Metal pins should be at least 4.7 mm (3/16 in) diameter steel with a 38 mm (1½ in) steel washer at the head of the pin. Wire staples and metal pins should be driven flush to the soil surface. All anchors should be between 200-450 mm (8-18 in) long and have sufficient ground penetration to resist pullout. Longer anchors may be required for loose soils. Heavier metal stakes may be required in rocky soils.

Anchor Pattern Guide

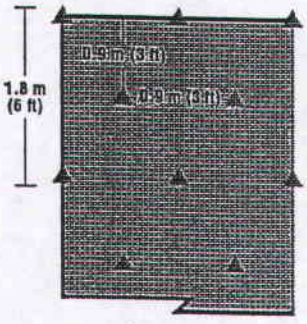
The colored areas in the adjacent diagram provide anchor recommendations based on slope gradient and/or anticipated flow conditions. When the correct number of anchors has been determined, refer to the four illustrations below to establish anchor pattern. All overlaps should be anchored at a 450 mm (18 in) frequency.

Increased anchoring may be required depending upon site conditions. Soil filling immediately after installation will decrease the recommended anchoring rate to the next lowest pattern. Example: Soil filling of matting in high velocity channels will reduce anchor pattern to 2½ per m² (2 per yd²).

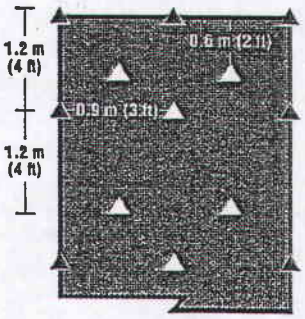




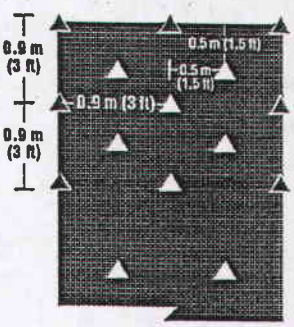
1.2 ANCHORS/m²
(1 ANCHOR/yd²)



1.8 ANCHORS/m²
(1½ ANCHORS/yd²)



2.5 ANCHORS/m²
(2 ANCHORS/yd²)



3 ANCHORS/m²
(2½ ANCHORS/yd²)

use this anchor pattern

Soil Filling (Optional)

- Pyramat® is designed to be filled with soil after installation. This maximizes performace of the product. Contact SI Engineering Services for a more detailed explanation of the benefits of soil filling TRMs.
- After seeding, spread and lightly rake 12-19 mm (1/2-3/4 in) of fine topsoil into the Pyramat and completely fill the voids. Use backside of rake or other flat tool to ensure a smooth soil-filled surface.
- Important! Smooth soil fill in order to just expose the top of matrix. Do not place excessive soil above the mat.
- Pyramat will withstand lightweight rubber-tired construction equipment. No tracked equipment or sharp turns should be made on the mat.
- Avoid any traffic over Pyramat if very loose or wet soil conditions exist.
- Use shovels, rakes or brooms for fine grading and finishing.
- Broadcast additional seed and mulch above the soil-filled Pyramat, if desired.
- If possible, water as necessary to enhance growth.
- **Consult manufacturer's technical representative or local distributor for installation assistance, particularly if unique conditions apply (i.e. fine sandy soils, infertile environments).**

SMART SOLUTIONS®

Analyzing and solving civil and environmental problems is our focus. We want to work with you on your next project.

FOR ADDITIONAL INFORMATION, PLEASE CALL:

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Office: (423) 899-0444 Fax: (423) 899-7619
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SI® Geosolutions

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GPD-PM-102

Printed in USA
5/00-10M

Castle Gate Holding Company
Castle Gate Mine
C/007/004

Phase I Bond Release on 1.7 acres of disturbed lands associated with the Adit No. 1 in the canyon along US Highway 6, west of the Castle Gate area.

I hereby certify to the best of my information and belief that all applicable reclamation activities have been accomplished in accordance with the requirements of the Act, the regulatory program, and the approved reclamation plan.

Dennis N. Ware
Print Name

Controller & Admin. Mgr
Sign Name, Position, Date

05-03-2005

Subscribed and sworn to before me this 3rd day of May, 2005

Tanya Short
Notary Public

TANYA SHORT
NOTARY PUBLIC • STATE of UTAH
55 S 500 W PO BOX 371
ORANGEVILLE, UT 84537
COMM. EXP. 6-4-2005

My Commission Expires: 6-4, 2005

Attest: State of Utah } ss:
County of Emery

AFFIDAVIT OF PUBLICATION

STATE OF UTAH)

ss.

County of Carbon,)

I, Ken Larson, on oath, say that I am the Publisher of the Sun Advocate, a twice-weekly newspaper of general circulation, published at Price, State a true copy of which is hereto attached, was published in the full issue of such newspaper for 4 (Four) publication was on the 21st day of June, 2005, and that the last publication of such notice was in the issue of such newspaper dated the 12th day of July, 2005.

Ken G. Larson

Ken G Larson - Publisher

Subscribed and sworn to before me this 12th day of July, 2005.

Linda Thayn

Notary Public My commission expires January 10, 2007 Residing at Price, Utah

Publication fee, $ 465.92

LINDA THAYN
NOTARY PUBLIC • STATE of UTAH
845 EAST MAIN
PRICE, UTAH 84501
COMM. EXPIRES 1-10-2007

PUBLIC NOTICE

APPLICATION FOR PHASE I BOND RELEASE
AUDIT NO. 1
CASTLE GATE HOLDING COMPANY
CASTLE GATE MINE
PERMIT C/007/004, APPROVED 12/24/1999
CARBON COUNTY, UTAH

Castle Gate Holding Company, 999 Corporate Blvd., Linthicum Heights, MD 21090, has completed Phase I of the approved reclamation plan for the approximately 3.0 acres of land in the Adit No. 1 are of the Castle Gate Mine. This is based on meeting the backfilling and grading and drainage control requirements for Phase I reclamation in accordance with the approved reclamation plan. All earthwork, drainage control, and revegetation were completed on site in the fall of 2002.

In accordance with the provision of R645-301-880, of the State of Utah R645-Coal Mining Rules, notice is hereby given to the general public that Castle Gate Holding Company is applying for partial release of the performance bond posted for this operation.

The surety bond posted for the Castle Gate Mine is $680,154 of which $129,054 is designated for the Adit No. 1 reclamation. Castle Gate Holding Company is seeking release of $77,432 from the Adit No. 1 portion of the bond.

The Adit No. 1 area is located on the Helper, Utah, U.S. Geological Survey 7.5 minute quadrangle map. The site is located in Price Canyon approximately 3 miles north of Helper, Utah on the following described lands:

Township 13 South, Range 9 East, SLB&M, Utah
Section 1: NW1/4 NW1/4

The Utah Division of Oil, Gas and Mining will now evaluate the proposal to determine whether it meets all the criteria of the Permanent Program Performance Standards according to the requirements of the Utah Coal Mining Rules.

Written comments, objections and requests for public hearing or information conference on this proposal may be addressed to:

Utah Coal Program
Utah Division of Oil, Gas and Mining
1594 West North Temple, Suite 1210
PO Box 145801
Salt Lake City, Utah 84114-5801

Closing date for submission of such comments, objections and request for public hearing or information conference on this proposals must be submitted by August 12, 2005.

Published in the Sun Advocate June 21, 28, July 5 and 12, 2005.

CASTLE GATE HOLDING COMPANY
Castle Gate Mine
P.O. Box 30
847 NW HWY 191
Helper, Utah 84526
(435)472-4737
Fax: (435)472-4782

April 29, 2005

Mr. Dave Levanger
Carbon County Planning and Zoning
120 East Main Street
Price, Utah 84501

Re: Notification of Application for Phase I Bond Release, Adit No. 1, Castle Gate Holding Company, Castle Gate Mine, C/007/004, Carbon County, Utah

Dear Mr. Levanger:

Castle Gate Holding Company, 999 Corporate Blvd., Linthicum Heights, MD 21090, has completed Phase I of the approved reclamation plan for the approximately 3.0 acres of land in the Adit No. 1 area of the Castle Gate Mine. This is based on meeting the backfilling and grading and drainage control requirements for Phase I reclamation in accordance with the approved reclamation plan. All earthwork, drainage control, and revegetation were completed on site in the fall of 2002.

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Section 1: NW1/4 NW1/4

Comments concerning Phase I bond release from the legal or equitable owner of record of the surface areas to be affected and from the Federal, Utah and local government agencies which would have to initiate, implement, approve, or authorize the proposed use of the land following reclamation should be mailed to: Plateau Mining Corporation, Attention: Dennis N. Ware, P.O. Box 30, Helper, Utah 84526.

If you have any questions or need additional information, please contact me at (435) 472-4737.

Sincerely,

Dennis N. Ware
Controller and Administrative Manager

Env: Environmental/Permit Actions Castle Gate/Adit No. 1/Land Owner Notification Phase I

CASTLE GATE HOLDING COMPANY
Castle Gate Mine
P.O. Box 30
847 NW HWY 191
Helper, Utah 84526
(435)472-4737
Fax: (435)472-4782

April 29, 2005

Mr Gary Harwood
Helper City
P.O. Box 221
Helper, Utah 84526

Re: Notification of Application for Phase I Bond Release, Adit No. 1, Castle Gate Holding Company, Castle Gate Mine, C/007/004, Carbon County, Utah

Dear Mr. Harwood:

Castle Gate Holding Company, 999 Corporate Blvd., Linthicum Heights, MD 21090, has completed Phase I of the approved reclamation plan for the approximately 3.0 acres of land in the Adit No. 1 area of the Castle Gate Mine. This is based on meeting the backfilling and grading and drainage control requirements for Phase I reclamation in accordance with the approved reclamation plan. All earthwork, drainage control, and revegetation were completed on site in the fall of 2002.

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Dennis N. Ware
Controller and Administrative Manager

Env: Environmental/Permit Actions Castle Gate/Adit No. 1/Land Owner Notification Phase I

CASTLE GATE HOLDING COMPANY
Castle Gate Mine
P.O. Box 30
847 NW HWY 191
Helper, Utah 84526
(435)472-4737
Fax: (435)472-4782

April 29, 2005

Mr. Harold Cunningham
Utah Power and Light – Carbon Plant
Helper, Utah 84526

Re: Notification of Application for Phase I Bond Release, Adit No. 1, Castle Gate Holding Company, Castle Gate Mine, C/007/004, Carbon County, Utah

Dear Mr. Cunningham:

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Sincerely,

Dennis N. Ware
Controller and Administrative Manager

Env: Environmental/Permit Actions Castle Gate/Adit No. 1/Land Owner Notification Phase I

CASTLE GATE HOLDING COMPANY
Castle Gate Mine
P.O. Box 30
847 NW HWY 191
Helper, Utah 84526
(435)472-4737
Fax: (435)472-4782

April 29, 2005

Carbon County Commissioners
120 East Main Street
Price, Utah 84501

Re: Notification of Application for Phase I Bond Release, Adit No. 1, Castle Gate Holding Company, Castle Gate Mine, C/007/004, Carbon County, Utah

Dear Commissioners:

Castle Gate Holding Company, 999 Corporate Blvd., Linthicum Heights, MD 21090, has completed Phase I of the approved reclamation plan for the approximately 3.0 acres of land in the Adit No. 1 area of the Castle Gate Mine. This is based on meeting the backfilling and grading and drainage control requirements for Phase I reclamation in accordance with the approved reclamation plan. All earthwork, drainage control, and revegetation were completed on site in the fall of 2002.

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If you have any questions or need additional information, please contact me at (435) 472-4737.

Sincerely,

Dennis N. Ware
Controller and Administrative Manager

Env: Environmental/Permit Actions Castle Gate/Adit No. 1/Land Owner Notification Phase I

CASTLE GATE HOLDING COMPANY
Castle Gate Mine
P.O. Box 30
847 NW HWY 191
Helper, Utah 84526
(435)472-4737
Fax: (435)472-4782

April 29, 2005

Mr. Phil Palmer
Price River Water Improvement District
P.O. 903
265 South Fairgrounds Road
Price, Utah 84501

Re: Notification of Application for Phase I Bond Release, Adit No. 1, Castle Gate Holding Company, Castle Gate Mine, C/007/004, Carbon County, Utah

Dear Mr. Palmer:

Castle Gate Holding Company, 999 Corporate Blvd., Linthicum Heights, MD 21090, has completed Phase I of the approved reclamation plan for the approximately 3.0 acres of land in the Adit No. 1 area of the Castle Gate Mine. This is based on meeting the backfilling and grading and drainage control requirements for Phase I reclamation in accordance with the approved reclamation plan. All earthwork, drainage control, and revegetation were completed on site in the fall of 2002.

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If you have any questions or need additional information, please contact me at (435) 472-4737.

Sincerely,

Dennis N. Ware
Controller and Administrative Manager

Env: Environmental/Permit Actions Castle Gate/Adit No. 1/Land Owner Notification Phase I

CASTLE GATE HOLDING COMPANY
Castle Gate Mine
P.O. Box 30
847 NW HWY 191
Helper, Utah 84526
(435)472-4737
Fax: (435)472-4782

April 29, 2005

Mr. Patrick Gubbins
Bureau of Land Management
125 South 600 West
Price, Utah 84501

Re: Notification of Application for Phase I Bond Release, Adit No. 1, Castle Gate Holding Company, Castle Gate Mine, C/007/004, Carbon County, Utah

Dear Mr. Gubbins:

Castle Gate Holding Company, 999 Corporate Blvd., Linthicum Heights, MD 21090, has completed Phase I of the approved reclamation plan for the approximately 3.0 acres of land in the Adit No. 1 area of the Castle Gate Mine. This is based on meeting the backfilling and grading and drainage control requirements for Phase I reclamation in accordance with the approved reclamation plan. All earthwork, drainage control, and revegetation were completed on site in the fall of 2002.

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If you have any questions or need additional information, please contact me at (435) 472-4737.

Sincerely,

Dennis N. Ware
Controller and Administrative Manager

Env: Environmental/Permit Actions Castle Gate/Adit No. 1/Land Owner Notification Phase I

CASTLE GATE HOLDING COMPANY
Castle Gate Mine
P.O. Box 30
847 NW HWY 191
Helper, Utah 84526
(435)472-4737
Fax: (435)472-4782

April 29, 2005

Mr. Kevin S. Carter
Director
School and Institutional Trust Lands Administration
675 East 500 South, Suite 500
Salt Lake City, Utah 84102-2818

Re: Notification of Application for Phase I Bond Release, Adit No. 1, Castle Gate Holding Company, Castle Gate Mine, C/007/004, Carbon County, Utah

Dear Mr. Carter:

Castle Gate Holding Company, 999 Corporate Blvd., Linthicum Heights, MD 21090, has completed Phase I of the approved reclamation plan for the approximately 3.0 acres of land in the Adit No. 1 area of the Castle Gate Mine. This is based on meeting the backfilling and grading and drainage control requirements for Phase I reclamation in accordance with the approved reclamation plan. All earthwork, drainage control, and revegetation were completed on site in the fall of 2002.

In accordance with the provisions of R645-301-880 of the State of Utah R645 Coal Mining Rules, this letter will serve as notification that Castle Gate Holding Company intends to file an application with the Utah Division of Oil, Gas and Mining for partial release of the performance bond posted for this operation.

The surety bond posted for the Castle Gate Mine is $680,154 of which $129,054 is designated for the Adit No. 1 reclamation. Castle Gate Holding Company is seeking release of $77,432 from the Adit No. 1 portion of the bond.

The Adit No. 1 area is located on the Helper, Utah, U.S. Geological Survey 7.5 minute quadrangle map. The site is located in Price Canyon approximately 3 miles north of Helper, Utah on the following described lands:

Township 13 South, Range 9 East, SLB&M, Utah
Section 1: NW1/4 NW1/4

Comments concerning Phase I bond release from the legal or equitable owner of record of the surface areas to be affected and from the Federal, Utah and local government agencies which would have to initiate, implement, approve, or authorize the proposed use of the land following reclamation should be mailed to: Plateau Mining Corporation, Attention: Dennis N. Ware, P.O. Box 30, Helper, Utah 84526.

If you have any questions or need additional information, please contact me at (435) 472-4737.

Sincerely,

Dennis N. Ware
Controller and Administrative Manager

Env: Environmental/Permit Actions Castle Gate/Adit No. 1/Land Owner Notification Phase I

CASTLE GATE HOLDING COMPANY
Castle Gate Mine
P.O. Box 30
847 NW HWY 191
Helper, Utah 84526
(435)472-4737
Fax: (435)472-4782

April 29, 2005

Mr. Hugh Kirkham
State of Utah
Department of Transportation
940 South Carbon Avenue
Price, Utah 84501

Re: Notification of Application for Phase I Bond Release, Adit No. 1, Castle Gate Holding Company, Castle Gate Mine, C/007/004, Carbon County, Utah

Dear Mr. Kirkham:

Castle Gate Holding Company, 999 Corporate Blvd., Linthicum Heights, MD 21090, has completed Phase I of the approved reclamation plan for the approximately 3.0 acres of land in the Adit No. 1 area of the Castle Gate Mine. This is based on meeting the backfilling and grading and drainage control requirements for Phase I reclamation in accordance with the approved reclamation plan. All earthwork, drainage control, and revegetation were completed on site in the fall of 2002.

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If you have any questions or need additional information, please contact me at (435) 472-4737.

Sincerely,

Dennis N. Ware
Controller and Administrative Manager

Env: Environmental/Permit Actions Castle Gate/Adit No. 1/Land Owner Notification Phase I

CASTLE GATE HOLDING COMPANY
Castle Gate Mine
P.O. Box 30
847 NW HWY 191
Helper, Utah 84526
(435)472-4737
Fax: (435)472-4782

April 29, 2005

Mr. Roger Wheeler
Director Land Management
American Electric Power
700 Morrison Road
Gahanna, Ohio 43230-6642

Re: Notification of Application for Phase I Bond Release, Adit No. 1, Castle Gate Holding Company, Castle Gate Mine, C/007/004, Carbon County, Utah

Dear Mr. Wheeler:

Castle Gate Holding Company, 999 Corporate Blvd., Linthicum Heights, MD 21090, has completed Phase I of the approved reclamation plan for the approximately 3.0 acres of land in the Adit No. 1 area of the Castle Gate Mine. This is based on meeting the backfilling and grading and drainage control requirements for Phase I reclamation in accordance with the approved reclamation plan. All earthwork, drainage control, and revegetation were completed on site in the fall of 2002.

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If you have any questions or need additional information, please contact me at (435) 472-4737.

Sincerely,

Dennis N. Ware
Controller and Administrative Manager

Env: Environmental/Permit Actions Castle Gate/Adit No. 1/Land Owner Notification Phase I